KOLEJ YAYASAN PELAJARAN JOHOR
PEPERIKSAAN AKHIR

NAMA KURSUS	:	**STRENGTH OF MATERIAL**
KOD KURSUS	:	**DKM 2093**
PEPERIKSAAN	:	**NOVEMBER 2016**
MASA	:	**3 JAM**

ARAHAN KEPADA CALON

1. Kertas soalan ini mengandungi **LIMA (5)** soalan.

2. Jawab semua soalan. Anda dikehendaki mula menjawab setiap jawapan di mukasurat baru. Terdapat rumus dan jadual pada bahagian belakang kertas soalan.

3. Calon tidak dibenarkan membawa masuk sebarang peralatan ke dalam bilik peperiksaan kecuali dengan kebenaran pengawas peperiksaan.

4. Sila pastikan bahan-bahan berikut diperoleh untuk sesi peperiksaan ini:
   i. Kertas Soalan
   ii. Buku Jawapan

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIBERITAHU

KERTAS SOALAN INI MENGANDUNGI 12 HALAMAN BERCETAK TERMASUK MUKA HADAPAN

This section have FIVE(5) question. Answer ALL question.
Bahagian ini mempunyai (5) soalan. Jawab semua soalan.

QUESTION 1 / ***Soalan 1***

(20 marks/ ***markah*****)**

Two solid steel shafts are connected by gears in **figure 1** below. Given that for each shaft G = 67 GPa and that the allowable shearing stress is 75 Mpa, determine:

(*a*) the largest torque T_0 that may be applied to the end of shaft *A*.
(*b*) the corresponding angle through which end *A* of shaft *AB* rotates.

Dua aci keluli yang kukuh yang dihubungkan dengan gear dalam ***rajah 1*** *di bawah. Diberi setiap aci mempunyai G = 67 GPa dan tegasan ricih yang dibenarkan adalah 75 Mpa, tentukan:*

a) Daya kilas yang terbesar T_0 yang digunakan pada hujung aci A
b) Sudut pada penghujung aci A dan B yang berputar.

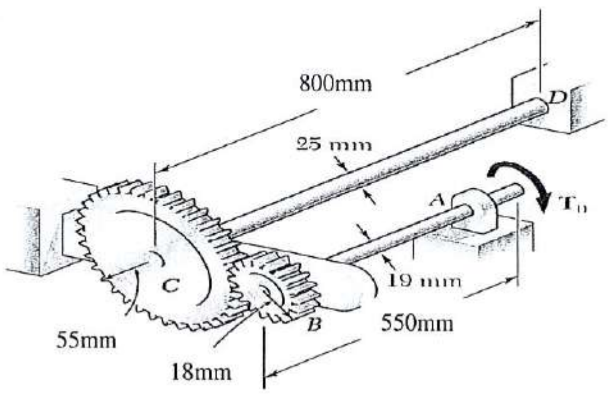


Figure 1 / ***Rajah 1***

QUESTION 2/ *SOALAN 2*

(20 marks/ *markah*)

At room temperature (20°C) a 0.5 mm gap exists between the ends of the rods shown in **figure 2** below. At a later time when the temperature has reached 140°C. Determine:

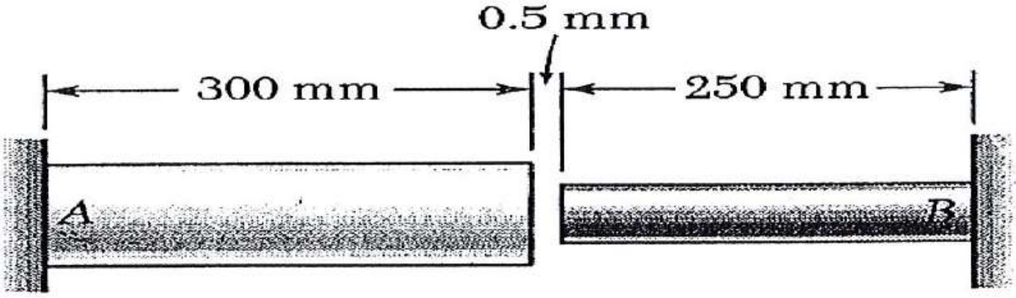
(a) The normal stress in the aluminum rod

(b) The change in length of the aluminum rod

Pada suhu bilik (20 ° C) terdapat jarak sebanyak 0.5 mm di antara setiap hujung rod seperti yang ditunjukkan dalam **rajah 2** di bawah. Suhu sebanyak 140 °C telah dicapai pada waktu yang berikutnya. Tentukan:

(a) Tegasan normal pada rod aluminium

(b) Perubahan panjang rod aluminium



Aluminum
$A = 2000\ mm^2$
$E = 75\ GPa$
$\alpha = 23 \times 10^{-6}/°C$

Stainless steel
$A = 800\ mm^2$
$E = 190\ GPa$
$\alpha = 17.3 \times 10^{-6}/°C$

Figure 2/ Rajah 2

QUESTION 3/ *SOALAN 3*

(20 marks/ *markah*)

A square box beam is constructed from four planks as shown in **figure 3** below. Knowing that the spacing between nails is 40 mm and the beam is subjected to a vertical shear of magnitude V = 2.3 kN, determine the shearing force in each nail.

Satu rasuk bersegi empat sama dibina daripada empat papan seperti yang ditunjukkan dalam ***rajah 3*** *di bawah.Diketahui bahawa jarak antara paku adalah 40* *mm dan rasuk dikenakan daya ricih secara menegak V = 2.3 kN, tentukan daya ricih pada setiap paku.*

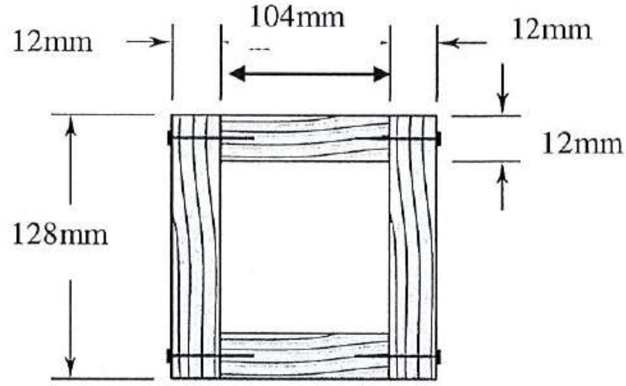


Figure 3/ *Rajah 3*

QUESTION 4 / *SOALAN 4*

(20 marks/ *markah*)

For the state of plane stress shown in **figure 4** below, determine :

(a) the principal planes

(b) the principal stresses

(c) the maximum shearing stress and the corresponding normal stress.

*Bagi satah tegasan yang ditunjukkan dalam **Rajah 4** di bawah, tentukan:*

a) Satah utama

b) Tegasan utama

c) Tegasan ricih maksimum dan tegasan normal yang sepadan.

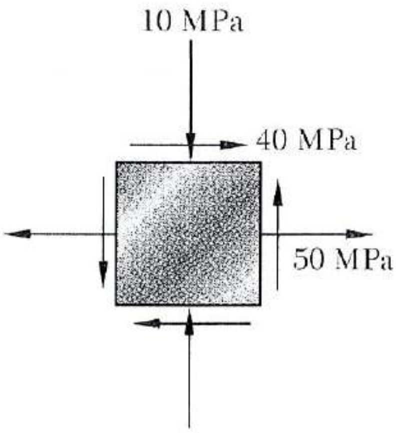


Figure 4/ Rajah 4

QUESTION 5/ *SOALAN 5*

(20 marks/ *markah*)

A simply supported steel beam is to carry the distributed and concentrated loads shown in **figure 5** below. Knowing that the allowable normal stress for the grade of steel to be used is 164 MPa, select the wide-flange shape that should be used.

*Satu rasuk keluli yang disokong adalah untuk membawa beban yang teragih seperti yang ditunjukkan dalam **Rajah 5** di bawah. Diketahui bahawa tegasan normal yang dibenarkan bagi gred keluli yang akan digunakan adalah 164 MPa, pilih bentuk lebar bebibir yang perlu digunakan.*

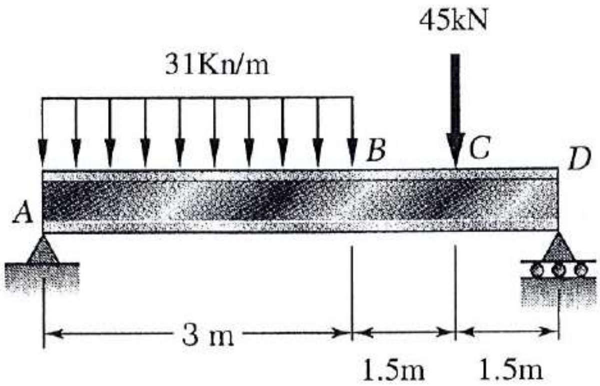


Figure 5/ *Rajah 5*

KERTAS SOALAN TAMAT

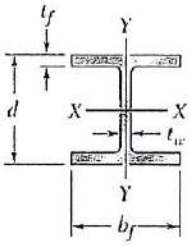
EQUATIONS AND TABLE /*RUMUS DAN JADUAL*

$\sigma = \frac{P}{A}$ = stress $\varepsilon = \frac{\delta}{L}$ = normal strain	$\alpha(\Delta T)L + \frac{PL}{AE} = 0$ $P = -AE\,\alpha(\Delta$ $\sigma = \frac{P}{A} = -E\alpha(\Delta T)$
$\delta T = \alpha \Delta T L$	$\tau = G\gamma$
$\tau_{ave} = \frac{P}{A}$	$\tau_{max} = \frac{Tc}{J}$ and $\tau = \frac{T\rho}{J}$
$\sigma = \frac{F}{A_\theta} = \frac{P\cos\theta}{A_0/\cos\theta} = \frac{P}{A_0}\cos^2\theta$ $\tau = \frac{V}{A_\theta} = \frac{P\sin\theta}{A_0/\cos\theta} = \frac{P}{A_0}\sin\theta\cos\theta$	$\gamma_{max} = \frac{c\phi}{L}$
$FS = \frac{\sigma_u}{\sigma_{all}}$	$\gamma_{max} = \frac{\tau_{max}}{G} = \frac{Tc}{JG}$
$\delta = \sum \frac{P_i L_i}{A_i E_i}$	$\phi = \sum_i \frac{T_i L_i}{J_i G_i}$
$\delta = \delta_L + \delta_R = 0$	$P = T\omega = 2\pi f T$ $T = \frac{P}{\omega} = \frac{P}{2\pi f}$

$\nu = \left\lvert \frac{\text{lateral strain}}{\text{axial strain}} \right\rvert = -\frac{\varepsilon_y}{\varepsilon_x} = -\frac{\varepsilon_z}{\varepsilon_x}$	$\tau_{max} = \frac{Tc}{J}$ $\frac{J}{c} = \frac{\pi}{2}c^3 = \frac{T}{\tau_{max}}$ (solid shafts) $\frac{J}{c_2} = \frac{\pi}{2c_2}\left(c_2^4 - c_1^4\right) = \frac{T}{\tau_{max}}$ (hollow sha
$\sigma_m = \frac{Mc}{I} = \frac{M}{S}$ $I =$ section moment of inertia $S = \frac{I}{c} =$ section modulus	$S = \frac{I}{c} = \frac{\frac{1}{12}bh^3}{h/2} = \frac{1}{6}bh^3 = \frac{1}{6}Ah$
$\sigma_m = \frac{Mc}{I}$	$\frac{1}{\rho} = \frac{M}{EI}$
$\sigma_x = -\frac{My}{I}$ $\quad \sigma_m = \frac{\lvert M \rvert c}{I} = \frac{\lvert M \rvert}{S}$	$\sigma_m = K\frac{Mc}{I}$
$\sigma_m \le \sigma_{all}$ $S_{min} = \frac{\lvert M \rvert_{max}}{\sigma_{all}}$	$\sigma_m \le \sigma_{all}$ $S_{min} = \frac{\lvert M \rvert_{max}}{\sigma_{all}}$
$q = \frac{\Delta H}{\Delta x} = \frac{VQ}{I} = shear\ flow$	$\tau_{ave} = \frac{\Delta H}{\Delta A} = \frac{q\,\Delta x}{\Delta A} = \frac{VQ}{I}\frac{\Delta x}{t\,\Delta x}$ $= \frac{VQ}{It}$
$\tau_{xy} = \frac{VQ}{Ib} = \frac{3}{2}\frac{V}{A}\left(1 - \frac{y^2}{c^2}\right)$ $\tau_{max} = \frac{3}{2}\frac{V}{A}$	$\tau_{ave} = \frac{VQ}{It}$ $\tau_{max} = \frac{V}{A_{web}}$

$\sigma_{x'} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta$ $\sigma_{y'} = \frac{\sigma_x + \sigma_y}{2} - \frac{\sigma_x - \sigma_y}{2}\cos 2\theta - \tau_{xy}\sin 2\theta$ $\tau_{x'y'} = -\frac{\sigma_x - \sigma_y}{2}\sin 2\theta + \tau_{xy}\cos 2\theta$
$q = \tau t = \frac{VQ}{I}$
$(\sigma_{x'} - \sigma_{ave})^2 + \tau_{x'y'}^2 = R^2$ where $\sigma_{ave} = \frac{\sigma_x + \sigma_y}{2}$ $R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$
$\sigma_{\max,\min} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$ $\tan 2\theta_p = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}$ Note: defines two angles separated by 90°.

$\tau_{\max} = R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$ $\tan 2\theta_s = -\frac{\sigma_x - \sigma_y}{2\tau_{xy}}$ Note: defines two angles separated by 90° and offset from θ_p by 45° $\sigma' = \sigma_{ave} = \frac{\sigma_x + \sigma_y}{2}$
$\sigma_{ave} = \frac{\sigma_x + \sigma_y}{2}$ $\quad R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$
$\sigma_{\max,\min} = \sigma_{ave} \pm R$ $\tan 2\theta_p = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}$



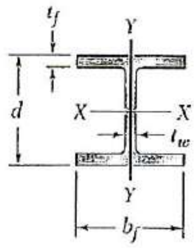
Appendix C. Properties of Rolled-Steel Shapes
(SI Units)

W Shapes
(Wide-Flange Shapes)

			Flange		Web	Axis X-X			Axis Y-Y		
Designation†	Area A, mm^2	Depth d, mm	Width b_f, mm	Thickness t_f, mm	Thickness t_w, mm	I_x 10^6 mm^4	S_x 10^3 mm^3	r_x mm	I_y 10^6 mm^4	S_y 10^3 mm^3	r_y mm
W920 × 446	57000	933	423	42.70	24.0	8470	18200	385	540	2550	97.3
201	25600	903	304	20.10	15.2	3250	7200	356	94.4	621	60.7
W840 × 299	38100	855	400	29.20	18.2	4790	11200	355	312	1560	90.5
176	22400	835	292	18.80	14.0	2460	5890	331	78.2	536	59.1
W760 × 257	32600	773	381	27.10	16.6	3420	8850	324	250	1310	87.6
147	18700	753	265	17.00	13.2	1660	4410	298	52.9	399	53.2
W690 × 217	27700	695	355	24.80	15.4	2340	6730	291	185	1040	81.7
125	16000	678	253	16.30	11.7	1190	3510	273	44.1	349	52.5
W610 × 155	19700	611	324	19.00	12.7	1290	4220	256	108	667	74.0
101	13000	603	228	14.90	10.5	764	2530	242	29.5	259	47.6
W530 × 150	19200	543	312	20.30	12.7	1010	3720	229	103	660	73.2
92	11800	533	209	15.60	10.2	552	2070	216	23.8	228	44.9
66	8370	525	165	11.40	8.9	351	1340	205	8.57	104	32.0
W460 × 158	20100	476	284	23.90	15.0	796	3340	199	91.4	644	67.4
113	14400	463	280	17.30	10.8	556	2400	196	63.3	452	66.3
74	9450	457	190	14.50	9.0	333	1460	188	16.6	175	41.9
52	6630	450	152	10.80	7.6	212	942	179	6.34	83.4	30.9
W410 × 114	14600	420	261	19.30	11.6	462	2200	178	57.2	438	62.6
85	10800	417	181	18.20	10.9	315	1510	171	18.0	199	40.8
60	7580	407	178	12.80	7.7	216	1060	169	12.1	136	40.0
46.1	5890	403	140	11.20	7.0	156	774	163	5.14	73.4	29.5
38.8	4990	399	140	8.80	6.4	127	637	160	4.04	57.7	28.5
W360 × 551	70100	455	418	67.60	42.0	2260	9930	180	825	3950	108
216	27600	375	394	27.70	17.3	712	3800	161	283	1440	101
122	15500	363	257	21.70	13.0	365	2010	153	61.5	479	63.0
101	12900	357	255	18.30	10.5	302	1690	153	50.6	397	62.6
79	10100	354	205	16.80	9.4	227	1280	150	24.2	236	48.9
64	8140	347	203	13.50	7.7	178	1030	148	18.9	186	48.2
57.8	7220	358	172	13.10	7.9	161	899	149	11.1	129	39.2
44	5730	352	171	9.80	6.9	122	693	146	8.18	95.7	37.8
39	4980	353	128	10.70	6.5	102.0	578	143	3.75	58.6	27.4
32.9	4170	349	127	8.50	5.8	82.7	474	141	2.91	45.8	26.4

†A wide-flange shape is designated by the letter W followed by the nominal depth in millimeters and the mass in kilograms per meter.

(Table continued on page 749)



Appendix C. Properties of Rolled-Steel Shapes
(SI Units)

Continued from page 751

W Shapes
(Wide-Flange Shapes)

Designation†	Area A, mm²	Depth d, mm	Flange Width b_f, mm	Flange Thickness t_f, mm	Web Thickness t_w, mm	Axis X-X I_x 10^6 mm⁴	Axis X-X S_x 10^3 mm³	Axis X-X r_x mm	Axis Y-Y I_y 10^6 mm⁴	Axis Y-Y S_y 10^3 mm³	Axis Y-Y r_y mm
W310 × 143	18200	323	309	22.9	14.0	348	2150	138	113	731	78.8
107	13600	311	306	17.0	10.9	248	1590	135	81.2	531	77.3
74	9480	310	205	16.3	9.4	165	1060	132	23.4	228	49.7
60	7590	303	203	13.1	7.5	129	851	130	18.3	180	49.1
52	6670	318	167	13.2	7.6	119	748	134	10.3	123	39.3
44.5	5690	313	166	11.2	6.6	99.2	634	132	8.55	103	38.8
38.7	4940	310	165	9.7	5.8	85.1	549	131	7.27	88.1	38.4
32.7	4180	313	102	10.8	6.6	65.0	415	125	1.92	37.6	21.4
23.8	3040	305	101	6.7	5.6	42.7	280	119	1.16	23.0	19.5
W250 × 167	21300	289	265	31.8	19.2	300	2080	119	98.8	746	68.1
101	12900	264	257	19.6	11.9	164	1240	113	55.5	432	65.6
80	10200	256	255	15.6	9.4	126	984	111	43.1	338	65.0
67	8580	257	204	15.7	8.9	104	809	110	22.2	218	51.0
58	7420	252	203	13.5	8.0	87.3	693	108	18.8	185	50.3
49.1	6250	247	202	11.0	7.4	70.6	572	106	15.1	150	49.2
44.8	5720	266	148	13.0	7.6	71.1	535	111	7.03	95.0	35.1
32.7	4180	258	146	9.1	6.1	48.9	379	108	4.73	64.8	33.7
28.4	3630	260	102	10.0	6.4	40.0	308	105	1.78	34.9	22.1
22.3	2850	254	102	6.9	5.8	28.9	228	101	1.23	24.1	20.8
W200 × 86	11000	222	209	20.6	13.0	94.7	853	92.4	31.4	300	53.2
71	9100	216	206	17.4	10.2	76.6	709	91.7	25.4	247	52.8
59	7560	210	205	14.2	9.1	61.1	582	89.9	20.4	199	51.9
52	6660	206	204	12.6	7.9	52.7	512	89.0	17.8	175	51.7
46.1	5860	203	203	11.0	7.2	45.5	448	87.9	15.3	151	51.1
41.7	5310	205	166	11.8	7.2	40.9	399	87.8	9.01	109	41.2
35.9	4580	201	165	10.2	6.2	34.4	342	86.7	7.64	92.6	40.8
31.3	4000	210	134	10.2	6.4	31.4	299	88.6	4.1	61.2	32.0
26.6	3390	207	133	8.4	5.8	25.8	249	87.2	3.3	49.6	31.2
22.5	2860	206	102	8.0	6.2	20.0	194	83.6	1.42	27.8	22.3
19.3	2480	203	102	6.5	5.8	16.6	164	81.8	1.15	22.5	21.5
W150 × 37.1	4730	162	154	11.6	8.1	22.2	274	68.5	7.07	91.8	38.7
29.8	3790	157	153	9.3	6.6	17.2	219	67.4	5.56	72.7	38.3
24.0	3060	160	102	10.3	6.6	13.4	168	66.2	1.83	35.9	24.5
18.0	2290	153	102	7.1	5.8	9.17	120	63.3	1.26	24.7	23.5
13.5	1730	150	100	5.5	4.3	6.87	91.6	63.0	0.918	18.4	23.0
W130 × 28.1	3580	131	128	10.9	6.9	10.9	166	55.2	3.81	59.5	32.6
23.8	3010	127	127	9.1	6.1	8.80	139	54.1	3.11	49.0	32.1
W100 × 19.3	2480	106	103	8.8	7.1	4.77	90.0	43.9	1.61	31.3	25.5

†A wide-flange shape is designated by the letter W followed by the nominal depth in millimeters and the mass in kilograms per meter.